

### 3.1 AORTIC INSUFFICIENCY

**AEROMEDICAL CONCERNS:** Acute complications from aortic insufficiency are rare. Chronic complications include left ventricular dilation and heart failure. There are theoretical concerns that the regurgitant flow of blood back into the LV may predispose the individual to GLOC, but this has not been confirmed. A secondary concern is that weight training to improve G-tolerance is relatively contraindicated, although such training is highly desirable in the tactical community.

**WAIVER:** Aortic insufficiency associated with a structural abnormality of the valve is CD, with no waiver for candidates. Designated individuals can receive waiver recommendations limited to non-high performance aircraft. Traditionally, AI has been felt not to occur in normal subjects, but NOMI and the Air Force Aeromedical Consult Service have detected a limited degree of AI in a number of patients without detectable valvular pathology. On echo, these "physiologic" AI cases typically have a very small AI jet that does not extend out of the LVOT. In these cases, the condition is NCD, and as such does not require a waiver.

#### **INFORMATION REQUIRED:**

**Note:** NOMI will often request the actual echo tape for review, so please request a duplicate of the tape for submission with the waiver request.

1. All cases of aortic insufficiency must have a full cardiology evaluation including echocardiography. The echo report must contain a quantitation of the degree of insufficiency according to the following:
  - a. Criteria for Grading:
    - i. Trivial AI is defined as a regurgitant flow with a pressure half-time of > 600 msec.
    - ii. Mild AI is a regurgitant flow with a pressure half time > 500 msec.
    - iii. Moderate AI has a pressure half-time greater than 200 but less than 500 msec.
    - iv. Severe AI has a pressure half-time < 200 msec.
  - b. Alternative Criteria measures the height ratio of the jet to the height of the LVOT in the parasternal long axis view:
    - i. A ratio from 0.1 to 0.24 is classified as trivial or mild, and correlates with Hunt's angiographic class 1 AI.
    - ii. A ratio of 0.25-0.46 indicates moderate AI, and corresponds to Hunt's class 2.
    - iii. A ratio of 0.47-0.64 indicates moderately severe AI and corresponds to Hunt's class 3.
    - iv. Severe AI (Hunt's class 4-5) is a ratio >0.65.
    - v. The previously expressed caveats regarding interpretation based on color flow appearance also apply.

**TREATMENT:** There is no treatment for asymptomatic aortic insufficiency. Annual echocardiography is recommended to screen for any signs of cardiac decompensation. If the individual has hypertension, it is advisable to treat it, as it will reduce the gradient for

regurgitation. Weight lifting should be discouraged, as it tends to increase the gradient for reflux back into the LV. SBE antibiotic prophylaxis is indicated for all cases of valvular insufficiency associated with an abnormal valve.

**DISCUSSION:** Physical findings associated with AI are generally a reflection of the reflux of blood back into the LV through the incompetent aortic valve. Corrigan's pulse is the rapidly collapsing pulse that is palpated in the carotids, or in the radials with the arm elevated. Quincke's pulses are the capillary pulsations that can be seen in the nail beds with gentle compression of the nail (the bed will alternately blanch and flush). A widened pulse pressure is characteristic, and aviators with exaggerated pulse pressures should probably have the diagnosis entertained. Diastolic murmurs are generally difficult to appreciate, but AI murmurs can be heard best with the diaphragm of the stethoscope along the left sternal border with the patient sitting up and leaning forward.

**BICUSPID AORTIC VALVES:** Because congenital bicuspid aortic valves can degenerate and progress to aortic stenosis or insufficiency, a bicuspid aortic valve is CD. Waivers will not be considered for applicants. If an incidental finding in designated aircrew, condition may be waiverable with possible restriction on aircraft or flight profile.

**ICD-9 CODES:**

**424.1 Aortic Insufficiency**

## 3.2 AORTIC STENOSIS

**AEROMEDICAL CONCERNS:** Aortic stenosis (AS) is generally well compensated over long periods of time. The cardinal manifestations of AS are angina, syncope and congestive heart failure. Angina is due either to CAD or the increased myocardial oxygen demands complicated by LVH. Syncope is frequently exercise related, and is generally the result of the inability of the heart to increase cardiac output. The compensatory LVH may also predispose the member to dysrhythmias, and result in syncope or sudden death.

**WAIVER:** Any degree of aortic stenosis is CD for aviation. Waivers to flight status may be considered only for designated individuals with mild AS (pressure gradient < 25 mm Hg). They are restricted to non-ejection seat aircraft, maritime/helo/ transport only.

### **INFORMATION REQUIRED:**

1. A full cardiology evaluation is necessary, with echocardiogram.
2. The echo report must include quantitation of the degree of stenosis.
  - a. Severe AS is generally defined as a valve area less than or equal to (0.7-0.8) cm<sup>2</sup>/M<sup>2</sup> BSA and/or left ventricular outflow tract (LVOT):aorta pressure gradient of greater than or equal to 50 mm Hg.
3. Maximal pressure gradients are a function of both valve area and myocardial performance. Therefore, determination of the degree of AS based solely on gradients may be misleading, and must factor in the state of the myocardium.

**DISCUSSION:** Aortic stenosis is defined as the reduction in the functional area of the aortic valve. Most commonly it is secondary to a congenitally bicuspid aortic valve. While bicuspid valves generally remain asymptomatic for prolonged periods, the abnormal valve invariably degenerates over time. Aortic stenosis and aortic insufficiency are the general result. Rheumatic heart disease can also affect the aortic valve, but the mitral valve is more often involved in rheumatic heart disease. Abnormal valves are susceptible to bacterial endocarditis, and as such, all patients who have been identified should receive SBE prophylaxis. The course of aortic stenosis is variable. In our experience, presentations range from the asymptomatic 65 year old to the 30 year old with critical aortic stenosis. Beta blockers are contraindicated, as they depress LV function and may precipitate acute decompensation. Diuretics should be used with caution, as hypovolemia may reduce cardiac output through its effects on preload reduction.

### **ICD-9 CODES:**

**747.2 Congenital Aortic Stenosis**

**424.1 Non-rheumatic Aortic Stenosis**

### 3.3 MITRAL REGURGITATION

**AEROMEDICAL CONCERNS:** Reduced exercise tolerance and sudden attacks of acute pulmonary edema in severe cases.

**WAIVER:** Waiver can be considered for mild mitral regurgitation provided it is not associated with mitral stenosis or connective tissue disease. Mild MR without abnormalities of the mitral valve, abnormalities of left atrial size or abnormalities of LV size will be NCD. Higher grades of valvular insufficiency, or valvular insufficiencies with structural abnormalities will be considered for waiver recommendation on a case by case basis.

#### **INFORMATION REQUIRED:**

1. A complete cardiology evaluation is required to confirm normal exercise tolerance, left ventricular size and function, and absence of arrhythmias or stenosis.
2. A regurgitant jet must be viewed in at least two planes at 90 degrees to each other.
3. In addition, the following criteria should be used to quantify the degree of regurgitation:
  - a. Trivial (physiologic) MR with no structural abnormality is NCD.
  - b. Mild MR is defined as restriction of the regurgitant jet to less than or equal to 2 cm behind the valve leaflets. Additionally, it should be 4 cm<sup>2</sup> or less by planimetry, or < 20% of the total LA area.
    - i. Should be reassessed by yearly echocardiography
  - c. Moderate MR is defined as extension of the jet to the mid-atrium.
  - d. Severe MR is defined as a flow velocity of 1.5 m/s. Severe MR should also show a jet area greater than or equal to 8 cm<sup>2</sup>, or > 40% of LA size. The flow should extend through more than 2/3 of systole. Prevalvular acceleration of the MR jet implies more significant regurgitation as well.
4. Because numerous variables can affect the apparent size of the jet and the assessment of severity is only semi-quantitative, moderate to severe MR diagnoses should be reviewed by NOMI.

**TREATMENT:** Antibiotic prophylaxis is necessary for all dental manipulations and potentially septic hazards. Associated left atrial enlargement may be severe enough to warrant anticoagulation.

**DISCUSSION:** MR is a common finding. Between 35-46% of normal 20-40 year old persons will show MR by echocardiography. MR can also be pathologic. Mitral regurgitation can be tolerated for many years without symptoms provided it is relatively minor. With severe regurgitation, the 5 year survival rate is less than 50%. (In the UK, even minor mitral regurgitation leads to some restriction in flying duties, usually away from high performance aircraft.)

#### **ICD-9 CODES:**

##### **424.0 Mitral Regurgitation**

### 3.4 MITRAL STENOSIS

**AEROMEDICAL CONCERNS:** Mitral stenosis has a varied clinical presentation. Hemoptysis can occur, and ranges from simply blood streaked sputum to frank hemorrhage. Although dramatic, it is rarely life-threatening. Atrial fibrillation is a frequent sequela of MS. Hemodynamic decompensation may result from atrial fibrillation, with or without a rapid ventricular response rate, as ventricular filling is highly dependent on atrial contraction (atrial kick), and/or a long diastolic filling time. MS may also present with chest pain. The dilated left atrium is prone to clot formation, and embolic events are not uncommon.

**WAIVER:** Any degree of mitral stenosis is CD, with no waiver recommended. Valve replacement surgery is not waived.

**INFORMATION REQUIRED:**

1. A full cardiology evaluation is required, with quantitation of the valve area and pressure gradient with echocardiogram or cardiac catheterization.

**FOLLOW-UP:** N/A

**DISCUSSION:** MS is usually the sequelae of rheumatic heart disease (RHD). RHD is uncommon in the U.S., but can be seen in older patients who developed rheumatic fever in the pre-antibiotic era. The patient becomes symptomatic 10-20 years after an attack of rheumatic fever, although an aggressive form has been reported in South Africa. Once symptomatic, the patient is usually incapacitated in 5-10 years. RVH is dependent on the RV systolic pressures, and should be suspected if the ECG shows the features of RVH. Pregnancy places an increased load on the heart, and can result in death from pulmonary edema and heart failure in women with significant mitral stenosis. Atrial fibrillation becomes chronic in over 50% of patients with mitral stenosis. Paroxysmal atrial fibrillation will occur in up to 80% of patients with mitral stenosis and of these, 20-30% will form atrial thrombi with subsequent embolization. Between 10 and 20% of patients with mitral stenosis, including those with only mild disease, can throw off emboli with a subsequent mortality rate of 15%. Once patients become symptomatic, survival is 50% at 4-5 years without surgery. After valve replacement, the 50% survival rate is improved to 10 years.

**ICD-9 CODES:**

**394.0 Mitral Stenosis**

### 3.5 MITRAL VALVE PROLAPSE

**AEROMEDICAL CONCERNS:** MVP syndrome symptoms vary in severity and are manifold in presentation. Arrhythmias are seen in a subset of MVP patients; most commonly premature ventricular beats, paroxysmal supraventricular and ventricular tachycardias. Non anginal chest pain often causes patients to seek medical attention. Palpitations, syncope and light-headedness have been reported, and sudden death is a rare complication. Of those patients who develop ventricular arrhythmias, approximately 50% have a history of syncopal or presyncopal episodes.

**WAIVER:** Candidates are not recommended for waiver, except for air traffic controllers. Designated personnel with minimal regurgitation, who do not require medication or have a history of significant arrhythmias may be considered for waiver.

**INFORMATION REQUIRED:**

1. Cardiology consultation is required to include:
  - a. Physical exam
  - b. Exercise testing
  - c. Holter monitoring
  - d. Echocardiogram.
2. "Echo only" MVP does not meet Navy criteria for diagnosis of MVP **syndrome** (click, murmur and prolapse in two echo views), but may be sufficient to result in disqualification from flight duties. Because of conflicting interpretations by local clinicians, all cases of suspected MVP will be reviewed by NOMI Internal Medicine.
3. A Local Board of Flight Surgeons is thus inappropriate until NOMI has reviewed the case (not via phone consult).

**FOLLOW-UP:** Yearly submission with submission of all tests except the stress test every three years, or as directed on waiver endorsement.

**TREATMENT:** Antibiotic prophylaxis is necessary for all dental procedures and "dirty" surgical procedures. Beta blockers have been used to reduce the subjective sensation of palpitations, but their use is CD, no waiver recommended.

**DISCUSSION:** There are probably several forms of MVP. Young women tend to have a relatively benign course, whereas older males have a greater tendency to develop dysrhythmias, endocarditis, and embolic events. MVP is a common finding in otherwise healthy young women. Depending on the series, MVP has been reported in 2-21% of healthy young women, and 5-15% in various other populations. The prevalence of MVP in women declines with advancing age. MVP can also be associated with connective tissue diseases like Marfan's syndrome, pseudoxanthoma elasticum and Ehlers-Danlos syndrome. While MVP is disqualifying for aviation, the criteria for diagnosis are strict. "Echo only" MVP may be disqualifying, but if the finding is noted on an echo report, the tape should probably be forwarded to NOMI for review. The Navy requires echocardiographic evidence of MVP in two views, the presence of a murmur and a mid-systolic click for diagnosis of the full syndrome. As significant changes in the diagnostic criteria have occurred within the last 10 years, it may be

worthwhile to restudy your patients who have carried the diagnosis for many years as they may no longer meet criteria for diagnosis.

**ICD-9 CODES:**

**424.0 Mitral Valve Prolapse**

### 3.6 VALVULAR CONDITIONS (OTHER)

**AEROMEDICAL CONCERNS:** The major concern is the relationship with mitral and aortic valve pathology. Pulmonic or tricuspid stenosis can both produce fatigue or shortness of breath. Tricuspid insufficiency is associated with arrhythmias.

**WAIVER:** Asymptomatic cases with mild functional abnormalities of the tricuspid or pulmonary valves may be considered for waiver in the absence of other pathology.

**INFORMATION REQUIRED:**

1. Cardiology consultation to demonstrate normal function, exercise tolerance and absence of arrhythmias.
2. NOMI evaluation and estimation of cardiac hemodynamics may be necessary. Usually, no further evaluation is required.

**TREATMENT:** Antibiotic prophylaxis for dental treatment and other septic risks.

**DISCUSSION:**

**Tricuspid or pulmonic stenosis:** These are uncommon conditions and are usually associated with congenital cardiac abnormalities. If detected, and if they are associated with other anomalies, they are CD, with no waiver recommended. Isolated pulmonic stenosis without detectable anomalies will be considered for waiver recommendation on a case-by-case basis.

**Tricuspid regurgitation:** TR is frequently encountered (40-70% of 20-40 year old normals). "Physiologic" TR is generally classified as a regurgitant flow with velocities of 0.20-0.26 M/s. Alternatively, the ratio of the jet to RV area as measured by planimetry can be performed. Mild TR is less than or equal to 20%, moderate TR is 20-34%, and severe TR is >35%. In the absence of RAE or RVH, mild to moderate TR is NCD.

**Pulmonic Insufficiency:** PI is also a common valvular abnormality, with a detected incidence of 50% in normal patients. If no other structural abnormalities are present, regurgitant jets extending 1-2 cm proximal to the valve will be NCD. Severe PI, with evidence of RAE or RVH is CD, with no waiver recommended.

**ICD-9 CODES:**

**Valvular Diseases Not Otherwise Specified:**

**424.0 Mitral Valve**

**424.1 Aortic Valve**

**424.2 Tricuspid Valve (Stenosis and Insufficiency)**

**424.3 Pulmonic Valve (Stenosis and Insufficiency)**



### 3.7 ARRHYTHMIAS (PAC/PVC/OTHER)

**AEROMEDICAL CONCERNS:** The concerns usually relate to presence of underlying heart disease. There is also a risk of progression to the development of symptoms or yet more severe arrhythmias which could be disabling in flight.

**WAIVER:** Waiver is not recommended for ventricular fibrillation or flutter. Most other conditions that have not been specifically addressed are waiverable provided there is no evidence of underlying heart disease. Some conditions require the flier to be grounded while undergoing evaluation while others allow a continuation of flying status. When in doubt, discuss the case with NOMI before making any decisions.

#### **INFORMATION REQUIRED:**

1. Patients with sinus pause (>2.5 sec), single or paired premature atrial contractions (PAC), single or paired junctional premature beats, supraventricular premature beat, idioventricular rhythm, uniform ventricular premature contraction (PVC), multiform PVC, or fused PVC should have a Holter monitor while remaining on flying status.
  - a. If this is normal, no further evaluation is necessary.
2. Patients with sinus bradycardia (<40 bpm) should have a rhythm strip performed during exercise if it cannot be accounted for by a vigorous exercise program.
  - a. If the individual cannot achieve 100 bpm or double the heart rate, a Holter monitor and treadmill test should be carried out while the aviator is grounded.
3. Patients with paired PVC's or PVC with R on T phenomenon require Holter monitor, treadmill test and echocardiogram while grounded.
  - a. If paired or frequent ectopic beats are seen on Holter monitoring (comprising >1% of all beats or >25% of all beats in any hour, or more than 5 per minute, or if multifocal), an echocardiogram and treadmill test should be performed.
4. In cases where ectopic beats comprise 10% or more of all beats or >25% in any hour or more than 10 pairs of ectopic beats are seen in 24 hours, the individual should be grounded and undergo NOMI evaluation.

**TREATMENT:** Drug therapy or pacing is not compatible with flying status.

**DISCUSSION:** On routine ECG, 1-5% of healthy adults exhibits some form of ventricular ectopy; this increases to 20-30% in a maximal exercise test and to 40-60% during 24-hour Holter monitoring. The incidence of ventricular ectopy and its rate increase exponentially with age. Between 5-10% will show complex ventricular ectopy (multiform PVCs, pairing or more of PVCs or R on T). In these cases, coronary artery disease, MVP, ventricular hypertrophy and cardiomyopathy need to be excluded. Although complex ectopy has been reported to be associated with an increased risk of sudden death, there has been no demonstration of prognostic importance in young, healthy runners, asymptomatic subjects during near-maximal exercise or in persons without clinical evidence of heart disease.

#### **ICD-9 CODES:**

##### **427.61 Premature Atrial Contractions**

## **427.69 Premature Ventricular Contractions**

### 3.8 ATRIAL FIBRILLATION (AFIB)

**AEROMEDICAL CONCERNS:** See atrial flutter.

**WAIVER:** The condition is CD. No waivers are recommended in recurrent cases or in candidates, but a return to full flight status is possible 6 months following a single episode of atrial fibrillation with a documented precipitating factor (e.g. Holiday Heart). No medications are waivable. Waivers are not recommended for candidates.

**INFORMATION REQUIRED:**

1. Complete cardiology consultation is required, to include:
  - a. Exercise treadmill testing
  - b. Echocardiography
  - c. Three Holter monitor studies at monthly intervals.
2. Exclusion of secondary causes is mandatory, including an exact detailed history of the event(s) (i.e. alcohol use, thyroid, stimulant use, sleep, stress, etc).

**DISCUSSION:** The condition is a result of chaotic atrial activity (P waves not discernible) at a rate generally between 350-600, with an irregularly irregular ventricular response (rate 120-160) except in patients on digoxin, beta blockers, high vagal tone, or intrinsic AV nodal disease. Causes are many: rheumatic heart disease (RHD), atrial septal defects (ASD), pulmonary emboli (PE), coronary artery disease (CAD), cardiomyopathies, postoperative heart surgery, hypertension, and pericarditis. A single episode of AFIB may occur without underlying heart disease, and can be associated with high caffeine intake, smoking, and excessive ETOH intake. In 50% of cases of atrial fibrillation, the cause is underlying disease such as left ventricular failure, mitral valve disease, pericardial disease, chronic obstructive lung disease, sinus node disease or hyperthyroidism. There is a 17-fold increase in stroke in patients with atrial fibrillation caused by mitral valve disease compared to a 5-fold increase in risk in patients where the fibrillation arises from all other causes. Cardioversion is 90% successful in restoring rhythm in flutter but there is a relatively high relapse rate (50%) in fibrillation. Patients with idiopathic, paroxysmal atrial fibrillation have no increased mortality compared to normals.

**ICD-9 CODE:**

**427.31 Atrial Fibrillation**

### **3.9 ATRIAL FLUTTER (AF)**

**AEROMEDICAL CONCERNS:** Acute atrial flutter may result in a runaway ventricular response rate. AF may be associated with chest pain, syncope or near syncope. There is a significantly increased incidence of embolic phenomena.

**WAIVER:** The condition is CD. Waivers are not recommended for recurrent atrial flutter or atrial fib/flutter in the absence of precipitating factors. A return to full flight status has been recommended for some cases of isolated atrial flutter with documented precipitating factors. Waivers are not recommended for candidates.

**INFORMATION REQUIRED:**

1. Complete cardiology consultation is required to include:
  - a. Exercise testing
  - b. Echocardiography
  - c. Three Holter monitors at monthly intervals
2. Individuals are grounded for six months pending evaluation.
3. No medications are waiverable.
4. Other secondary causes for atrial flutter must also be excluded (alcohol intoxication, hyperthyroidism).

**DISCUSSION:** An atrial rate (P wave) of 250-350 and varying degrees of AV block is the most common presentation, with 2:1 block the most common. Characteristic "saw-tooth" waves (flutter waves) may be seen in the inferior leads.

**ICD-9 CODE:**

**427.32 Atrial Flutter**

### 3.10 ATRIAL SEPTAL DEFECT (ASD)/PATENT FORAMEN OVALE

**AEROMEDICAL CONCERNS:** Physiologically, it is difficult to differentiate between patent foramen ovale (no murmur, no change in S2) and atrial septal defects (murmur, fixed split in S2). For the purposes of this discussion, the two conditions will be both considered "atrial septal defects". Atrial septal defects predispose individuals to several conditions. The known frequency of the condition in our age group and the relative lack of demonstrated pathology however argue against any significant effect. It has been postulated that ASD predisposes to decompression sickness (DCS). Valvular dysfunction can occur and pulmonary hypertension may develop.

**WAIVER:** Personnel found to have a Patent Foramen Ovale or hemodynamically stable ASD are PQ for aviation duty. Hemodynamically stable is defined as: (1) asymptomatic, (2) no right ventricular enlargement on echocardiogram, (3) no fixed splitting of S2, (4) normal EKG and (5) normal CXR. Designated aviators with surgically corrected ASD may be considered for waiver. Waivers are not recommended for candidates

#### **INFORMATION REQUIRED:**

1. Cardiological consultation to include contrast echocardiography is required.
2. NOMI evaluation may be required.
3. There is a risk of atrial dysrhythmias following surgical repair of an ASD.
  - a. Waiver recommendations for this group must include:
    - i. Serial Holter monitors (monthly over three months)
    - ii. Repeat contrast echocardiogram to document closure of the defect.

**TREATMENT:** Waiver is possible after surgical closure of ASD. The requirement for permanent pacing is disqualifying. SBE prophylaxis is not indicated for uncomplicated ASD. This is in contrast to VSD, where SBE prophylaxis is indicated for all potentially "dirty" procedures.

**DISCUSSION:** Atrial septal defects are extremely common. Autopsy series document "probe patent" foramen ovale in about 30% of cases in the 20-30 year old age group. The incidence decreases as age advances, falling to less than 1% in the 80+ year old population. As mentioned previously, pressure gradients determine flow across ASDs. Elevations in right sided pressures such as those caused either by positive pressure breathing or Valsalva maneuvers can raise the right atrial pressures over the left atrial pressures and flow across the septum can occur.

NOMI has studied over 50 cases of altitude DCS with contrast echocardiography, and we have been unable to demonstrate an increased prevalence of ASD in affected individuals. Roughly 30% of the DCS cases had an ASD, corresponding closely to the expected prevalence in this age group. Paradoxical embolism (from right to left) has been well documented in hospitalized patients, and theoretically gas bubbles can cross as well, leading to arterial gas emboli (AGE). The diving community is concerned about this possibility, and continues to exclude known ASD [PFO] cases from diving duty. They do not, however, pursue cases with anything remotely approaching zeal. Patients who have had repair of ASD may be more prone to arrhythmias. The

role of previously undiscovered ASD in the etiology of CNS decompression sickness is still controversial.

**ICD-9 CODES:**

**P35.71 ASD Repair**

**745.4 Ventricular Septal Defect**

**745.5 Atrial Septal Defect/Patent Foramen Ovale**

### 3.11 ATRIOVENTRICULAR CONDUCTION DISTURBANCES

**AEROMEDICAL CONCERNS:** There is a risk of bradycardia with decreased +Gz tolerance, syncope or sudden death in some conduction disturbances.

**WAIVER:** First degree atrioventricular (A-V) block and Mobitz Type I second degree A-V block (i.e. "Wenckebach block") are NCD, no waiver required, provided complete cardiology evaluation reveals no underlying disease. Patients with Mobitz Type II second degree A-V block and third degree A-V block are CD, no waiver.

#### **INFORMATION REQUIRED:**

1. First degree A-V block:
  - a. Local evaluation should include a rhythm strip performed during exercise, which may be calisthenics. The heart rate may need to be increased over 80-100 bpm.
    - i. If the PR interval shortens (it does not have to be normal) with increased heart rate no further evaluation is necessary.
    - ii. If P-R interval remains prolonged despite increased heart rate, a complete cardiology consultation including treadmill testing, echocardiography, and Holter monitor is required. Up to this stage, the aviator may remain on flying status during evaluation. If the tests are normal, no further evaluation is needed.
2. Second degree A-V block (Mobitz Type I) requires:
  - a. Cardiology consult, including treadmill and Holter monitor.

**TREATMENT:** Pacing is incompatible with flying status.

**DISCUSSION:** Most cases of first degree and Mobitz type I second degree heart block are related to increased vagal tone. Exercise reduces vagal tone and often reverses the block. Recent evidence suggests that in patients with Mobitz type I block refractory to exercise or atropine, syncope is common and the prognosis is similar to that for patients with Mobitz type II block. Syncope (the classic Adams-Stokes attack caused by transient asystole or ventricular fibrillation) occurs without warning. When the rhythm disturbance is short lived, some patients experience "near-syncope" or a feeling of dizziness.

#### **ICD-9 CODES:**

**426.11 First degree AV Block**

**426.12 Second degree AV Block, Mobitz I**

**426.13 Second degree AV Block, Mobitz II**

**426.0 Third degree AV Block**

### 3.12 CORONARY ARTERY DISEASE (CAD)

**AEROMEDICAL CONCERNS:** The major concern is the risk of sudden death or incapacitation in flight. Coronary artery disease is unpredictable and often catastrophic. Heat, hypoxia, hyperventilation, exposure to high work loads and high +Gz all increase myocardial oxygen demand. The presence of preexisting CAD can lead to decreased myocardial performance, dysrhythmias, angina, infarction, or sudden death.

**WAIVER:** Individuals with CAD are NPQ for all flying duties. Waiver recommendations may be made for fliers with minimal CAD (MCAD) as defined here. Gradeable lesions on angiography resulting in >10% and <30% occlusion of any coronary artery provided that the aggregate of occlusions is <100% may be considered for waiver recommendation. Aircrew with single lesions in a major epicardial artery >30%, any left main disease, an aggregate of lesions with the sum of the lesions >100% or who have a history of myocardial infarction or coronary artery surgery (including PTCA) are disqualified from flying, with no waivers recommended.

#### **INFORMATION REQUIRED:**

1. Aviators diagnosed with CAD need to be evaluated at NOMI prior to a waiver being recommended.

**FOLLOW-UP:** Annual cardiology examination, including interval history, physical examination and a non-invasive assessment for CAD (stress echocardiography, thallium or Sestamibi exercise treadmill testing). Cardiac catheterization is necessary if the non-invasive workup suggests ischemia.

**TREATMENT:** Drug therapy, other than prophylactic aspirin, is disqualifying, and a waiver will not be recommended.

**DISCUSSION:** The risk of sudden death from an unheralded heart attack at age 40/50/60 is 8/36/100 times greater than at age 30, and is the initial presentation in more than one third of myocardial infarctions. Up to 60% of patients die in the first hour. The literature suggests that individuals with normal coronary arteries on catheterization have a very low risk of experiencing a cardiac event within the next few years. For those with lesions from 10-30%, the 5 year mortality is the same as the general, unscreened population and the 10 year mortality is 13.8%. Those with lesions from 31-49% had a risk 2 times that of the general, unscreened population (5 year mortality). Patients with mild coronary artery disease (lesions <30%) can be considered for Service group 1, provided they are removed from the high +Gz environment. After angioplasty, restenosis may occur in 30% within 6 months with an additional 15% stenosing during the next 2-7 years. The risk of a cardiac event (infarct, death, bypass surgery) after angioplasty is 28% in 5 years in those with single vessel disease and 56% in 7 years in those with multivessel disease. Coronary artery bypass surgery will increase exercise tolerance and relieve angina in up to 85% of cases but the symptoms will recur in approximately 8% of the patients a year.

#### **ICD-9 CODES:**

**414.9 Coronary Artery Disease**



**P36.10 CABG within one year of exam**  
**P36.01 PTCA within one year of exam**

### 3.13 HYPERCHOLESTEROLEMIA

**AEROMEDICAL CONCERNS:** Risk of ischemic heart disease with increased plasma cholesterol and with increased low density lipoprotein (LDL).

**WAIVER:** Although there is little doubt that elevated cholesterol, or an unfavorable HDL-total cholesterol ratio is a risk factor for cardiovascular disease, hyperlipidemia/hypercholesterolemia is currently NCD for aviation, regardless of the lipid levels involved. Waivers are required only for some of the therapies used. **Waivers are not required for cholestyramine (Questran) or colestipol (Colestid), HMG Co-A Reductase inhibitors (statins as a class: Isovastatin, pravastatin, simvastatin and fluvastatin). Gemfibrozil (Lopid) requires a waiver, but recommendations are universally made for all Service Groups.** Patients requiring drug therapy should be grounded for a period of 14 days to assess response and observe for side effects.

#### **INFORMATION REQUIRED:**

1. Causes of secondary hyperlipidemia such as hypothyroidism, diabetes, cholestasis, alcohol abuse, gout, renal failure, nephrotic syndrome, myeloma and systemic lupus erythematosus should be excluded before therapy is initiated.
2. Personnel undergoing treatment with gemfibrozil require:
  - a. Liver function testing and CBCs prior to initiating RX and at 3, 6, and 9 months the first year, then annually thereafter.
  - b. Total cholesterol, HDL, TGs should be performed every 3 months for one year then every 6 months.
  - c. Report these with the annual physical.
  - d. We will consider a waiver to SG1 after two months of stable dosage and no side effects.
3. Persons on HMG Co-A Reductase inhibitors (statins) are recommended for:
  - a. Liver function testing (SGOT/SGPT/ALK PHOS) with CBC, CPK at baseline, at 3 and 6 months, then annually thereafter.
  - b. Liver elevations above three times normal will be disqualifying.
  - c. Notify NAMI Code 342 by flight physical or Aeromedical Summary (information only) to allow entry into the aviation database.

**TREATMENT:** First line treatment for mild cases are dietary control, weight reduction, increase in exercise and reduction in alcohol intake.

The next level of treatment for aircrew is with one of the anion exchange resins, Colestid or Questran. The major problems with both agents are hypersensitivity and the unpalatability of taking a large bulk of granules. Both drugs cause constipation that may worsen hemorrhoids and they both interact with other drugs, the relevant ones in aviation use being hydrochlorothiazide, penicillin and tetracycline.

The third line of therapy is with gemfibrozil or the statins. Gemfibrozil (Lopid) is indicated for quite high triglyceride levels and is not a first line drug of choice. Both drugs can have

hypersensitivity problems and both can cause hepatic dysfunction, necessitating regular liver function tests for the first 18 months of therapy. In both, dizziness, depression, headache and blurred vision have been reported. **Niacin is CD, no waiver; Probucol is CD, waiver may be considered for SG3.**

**DISCUSSION:** The incidence of heterozygous familial hypercholesterolemia in the USA is 1 in 500; in South Africans of Dutch descent it is 1 in 80. Of male heterozygotes, 50% will have ischemic heart disease by the time they are 50 years old. In familial hypertriglyceridemia, there is a risk of acute pancreatitis when the triglyceride level is >1000 mg/dl, and in severe cases, a rare incidence of peripheral neuropathy and dementia. The treatment of severe hypercholesterolemia has been shown to reduce the incidence of a first myocardial infarct. The treatment of mild/moderate cases is more controversial, some studies showing an increase in non-cardiovascular deaths in patients undergoing treatment with lipid lowering agents.

**ICD-9 CODE:**

**272.4 Hypercholesterolemia requiring medication for control**

### 3.14 HYPERTENSION

**AEROMEDICAL CONCERNS:** Untreated hypertension is associated with long term changes in the cardiovascular system that in toto have the effect of significantly reducing life span. Untreated hypertension also predisposes individuals to cerebrovascular accident, myocardial infarction, ophthalmologic disease and renal failure. The magnitude of the blood pressure elevation is directly proportional to the risk of developing complications and is increased by other risk factors such as hyperlipidemia or cigarette smoking. **White Coat Hypertension is not an acceptable diagnosis.** If the blood pressure exceeds standards at the time of exam, three day blood pressure checks (at two different times each day) are indicated. Previously high readings which are then normal on three day follow-up DO NOT relieve the examining flight surgeon from re-evaluation if the blood pressure is high during subsequent physical exams (or sick-call visits).

**WAIVER:** Any blood pressure exceeding 139 mmHg systolic or 89 mmHg diastolic is disqualifying and waiver will not be recommended. **Applicants requiring medication for control of blood pressure will not be recommended for a waiver.** The rational medical approach is to attempt non-pharmacological therapy first. If the systolic pressure is 150 mm or less and/or the diastolic 100 mm or less, member may continue to fly for a maximum of three months with Flight Surgeon's approval if asymptomatic and no evidence of end organ damage (see required information below). This allows for a trial of weight reduction, diet modification, exercise, etc... Clearance Notice should clearly state the three month limitation and the reason (pending blood pressure reduction measures). At the end of three months, if member is within aviation standards (<140/90), they are PQ. If not within standards, member is NPQ, and grounded for any remaining work-up and the initiation of therapy. **Blood pressure out of standards will not be waived;** the medications used to control it as outlined below. Unrestricted waivers are possible if adequate control of blood pressure is achieved (BP<140/90), there is no evidence of end-organ damage, and there are no significant medication side effects.

#### INFORMATION REQUIRED:

1. Documentation of good blood pressure control
2. Documentation of an absence of end organ damage
3. **Initial** evaluation should include:
  - a. CBC
  - b. CHEM 7 (serum electrolytes, glucose, urea nitrogen and creatinine)
  - c. TSH
  - d. Fundoscopic examination
  - e. Urinalysis
  - f. ECG
  - g. An echocardiogram may be required if there is any suggestion of ventricular hypertrophy by exam or ECG
  - h. Any pathology detected will require specialist evaluation
  - i. The [Hypertension AMS template](#) may simplify satisfying all submission requirements
4. **Follow Up (ANNUAL SUBMISSION REQUIRED)** should include:

- a. CHEM 7
- b. ECG
- c. Urinalysis
- d. Blood pressure measurements documenting control within aviation standards with an absence of side effects

**LIFESTYLE MODIFICATION:** The cornerstone of blood pressure management begins with lifestyle modification. Proper diet and adequate aerobic exercise will improve cardiovascular fitness and decrease the effects that hypertension can cause. Hypertension controlled by diet and exercise alone does not require a waiver. If patient has previously required medication for control, waiver will remain in effect, even if medications are subsequently no longer required. This will permit long-term tracking of aviation personnel with a history of hypertension. When lifestyle modifications alone are insufficient to control a patient's blood pressure, medical therapy will need to be initiated. Diet and exercise remain important adjuncts to therapy and should be encouraged at a level appropriate to the patient's age, current level of conditioning, and stage of hypertension. Medication recommendations for the aviation community differ from the general population and should not be used as a guide for treating non-aviation personnel.

**MEDICAL THERAPY:** After appropriate evaluation of an aviator with HTN (and a trial of diet and exercise therapy if blood pressure is less than 150/100) the use of **Angiotensin Converting Enzyme (ACE) Inhibitors** and **Hydrochlorothiazide (HCTZ)** can be used as **first line** agents for treatment of HTN in aviation personnel. ACE inhibitors are preferred as they have a low incidence of aeromedically significant side effects and are generally well tolerated. There are no dose restrictions on these medications as long as manufacturer recommended maximum doses are not exceeded. Use of **Angiotensin Converting Enzyme II Inhibitor (ACE-II)** medications can be used if aviators are intolerant to ACE inhibitors secondary to cough.

**Amlodipine**, a calcium channel antagonist, may be considered as a **second line** therapy either alone or in combination with ACE inhibitors, ACE-II or HCTZ. All **second line therapy waivers** are restricted to **SG III, Class 2 non-tactical aircraft and all Class 3.**

**Beta blockers** are not compatible with waivers for Service Groups I or II. Senior officers (LCDR and above) may be waived to SG3 or Class II flying duties in non-tactical aircraft. Air controllers are usually waived. All SGI or SGII or tactical NFOs are NPQ, no waiver. We don't want them pulling more than 2.5 Gs so requests should state "transport/maritime/helo aircraft only." If beta blockers are used, we prefer the use of the more cardioselective agents.

All personnel requesting a waiver should have their blood pressure adequately controlled (<140 systolic and <90 diastolic), be free of side effects, and have no complications from their hypertension. All waiver requests outside these guidelines should consult NAMI Internal Medicine.

**SECONDARY HYPERTENSION:** Secondary hypertension that has been surgically or medically corrected may also be considered for a waiver. There should be no complications or

side effects from the treatment, no permanent sequelae from the hypertension and the patient should be normotensive prior to a waiver being requested.

**DISCUSSION:** In the Framingham study, the mortality of individuals with hypertension was more than double that of the normotensive population, with most of the deaths occurring suddenly. The risk of cardiovascular events increases with age, tobacco use, male gender, positive family history, excess alcohol intake and high blood lipid levels; the presence of one or more of these risk factors will be considered in the final aviation disposition of the case. Several studies have demonstrated a reduction in mortality and morbidity resulting from the treatment of hypertensive patients. Beta blockers may cause sedation, affect Gz tolerance and have other side effects. One study has demonstrated a reduction in G tolerance in normotensive individuals given captopril. Our experience has not suggested that this is a significant problem in the population in whom its use is indicated.

**ICD-9 CODES:**

**401.9 Primary Hypertension**

**401.91 HTN controlled with medication**

### 3.15 HYPERTROPHIC CARDIOMYOPATHY

**AEROMEDICAL CONCERNS:** These patients have significant risk of developing dysrhythmias. Angina may also be a complicating factor, and can be due either to superimposed coronary artery disease or ischemia from extrinsic compression of the penetrating branches of the major epicardial vessels. If the hypertrophic changes involve the LV outflow tract, a functional outflow tract obstruction can result, with the attendant reduction in cardiac output and exercise tolerance. There is an annual mortality of 3.4% without surgery. Surgery for obstructive myopathy (myotomy, myectomy) has a mortality of 5-10% and the long term gain is uncertain.

**WAIVER:** True primary hypertrophic cardiomyopathy (e.g., IHSS) is rare, and is not usually discovered until post-mortem. This condition is disqualifying for general duty, and no waivers are recommended either for accession to general duty or special duty. Waiver will only be considered in the very mildest of cases with no hemodynamic and minimal echocardiographic abnormalities and after the exclusion of underlying pathology. If the myopathy is secondary to other pathology, that condition is the basis of disqualification. If the hypertrophic changes are documented to have resolved after treatment, a waiver recommendation may be considered. The majority of patients with idiopathic cardiomyopathy are disqualified from military flying. If a waiver is requested, refer to NOMI for evaluation.

#### **INFORMATION REQUIRED:**

1. Cardiology consultation is required, which should include:
  - a. Echocardiography and cardiac catheterization if indicated
  - b. Exclusion of underlying secondary causes for hypertrophic cardiomyopathy such as hypertension, pulmonary hypertension, valvular disorders, and hyperthyroidism

**TREATMENT:** Treatment, either medical or surgical, is CD, no waiver.

**DISCUSSION:** True hypertrophic cardiomyopathy is uncommon in the aviation population. Frequent referrals to NOMI Internal Medicine are made because of an ECG implication of LVH, but they are rarely substantiated by echo. Please refer to the section on LVH for guidelines to the diagnostic criteria we recommend for LVH. Echo remains the gold standard, and any questions can usually be resolved by a quick referral. Unfortunately, accurate standards for the diagnosis of pathologic LVH do not exist for our population, so we generally take several factors into account in deciding how much myocardium is too much. A "physiologic" form of LVH can be seen in some athletes, particularly those who engage in weight training. Runners and swimmers generally do not manifest significant LVH, even at Olympic levels of training. We are frequently asked to make decisions on LVH in athletic, but not world class, individuals. These hypertrophic changes can be usually be distinguished from primary forms in that they are concentric, and diastolic function is well preserved. The end diastolic dimension of the ventricle is either normal or increased in size. In pathologic LVH the ventricular cavity is obliterated at end systole, and diastolic dysfunction is the rule.

Hypertrophic cardiomyopathy also presents most frequently in the 20's. In a military population it is important to exclude athletic heart syndrome. The level of hypertrophy and the severity of the hemodynamic changes do not help to determine the prognosis. Poor prognosticators are a family history of sudden death, diagnosis in childhood and a history of blackouts.

**ICD-9 CODE:**

**425.4 Hypertrophic Cardiomyopathy**



### 3.16 INTRAVENTRICULAR CONDUCTION ABNORMALITIES

**AEROMEDICAL CONCERNS:** Left bundle branch block (LBBB) is usually associated with coronary artery disease. Right bundle branch block (RBBB), especially as a new finding, may also be associated with heart disease, particularly atrial septal defects.

**WAIVER:**

1. **RBBB, LAHB, LPHB** are NCD if a non invasive workup (Holter monitor, treadmill and echocardiogram) is normal.
2. **LBBB** is CD. No waiver recommended for non-designated personnel. Waiver is possible for designated aviators with LBBB in the documented absence of coronary artery disease and if asymptomatic.
3. **Bifascicular blocks (LAHB or LPHB with RBBB)** are CD, no waiver recommended.
4. **Trifascicular blocks** (1st degree AVB with RBBB and either LAHB or LPHB) are CD, no waivers.
5. **Incomplete RBBB** is NCD, with no workup required. Please refrain from using the term "Non specific intraventricular conduction delay".

**INFORMATION REQUIRED:**

1. Complete cardiology evaluation is necessary for LBBB, RBBB, left posterior hemiblock and left anterior hemiblock (LAH) if this last ECG is a sudden change from previous ECGs.
2. If LAH is found:
  - a. If younger than 35 years and no previous recordings are available, an echocardiogram should be performed to rule out congenital heart disease.
  - b. If older than 35 with no previous ECGs available, a treadmill test as well as an echocardiogram should be performed.
  - c. Pending these evaluations, persons with LAH may remain on flying status.
  - d. If the studies are normal, no further evaluation is required.
  - e. If LAH develops slowly over some years as a result of progressive left axis deviation, no further evaluation is required .
  - f. A standard treadmill in any patient with any conduction defect may be unreliable. Stress echocardiography or thallium stress test is preferred.

**TREATMENT:** N/A.

**DISCUSSION:** RBBB occurs on up to 2 per 1000 ECGs. It is often congenital (check earlier ECGs) or develops at high heart rates. If it has been present for years, is not associated with symptoms, and is accompanied by an otherwise normal cardiac examination, RBBB carries no known adverse risk or prognostic significance. One report states that the risk of RBBB progressing to complete block is "a few percent a year". The risk increased when RBBB is associated with left posterior fascicular block or when RBBB and LBBB alternate. In the absence of heart disease, acquired RBBB carries the same risk for death or syncope as the general population. Similarly, isolated left anterior fascicular block carries no known increased risk; not enough is known about isolated left posterior fascicular block to prognosticate with

certainty. In the absence of demonstrable pathology there is no justification for disqualification. Persons with known, recently acquired LBBB have a 10-fold increase in mortality compared to normals. Approximately 10-20% of patients with asymptomatic LBBB have coronary artery disease on catheterization.

**ICD-9 CODES:**

**426.4 Right BBB**

**426.3 Left BBB**

**426.2 Left BBB (hemiblock)**

### 3.17 LEFT VENTRICULAR HYPERTROPHY

**AEROMEDICAL CONCERNS:** An increase in left ventricular mass has been shown in several series to be associated with dysrhythmias, angina or sudden death. Idiopathic or secondary cardiomyopathies are discussed separately.

**WAIVER:** In our population, LVH based on ECG criteria is usually a false positive. Current criteria, based on the general population, are not valid for our young, athletic population. True LVH is CD, no waiver recommended for all duties involving flying. Elevated voltages on ECG are NCD provided the echocardiogram is normal.

#### **INFORMATION REQUIRED:**

1. Echocardiography remains the gold standard, and must be obtained if there is ECG evidence for LVH.
  - a. If the EKG meets either of the criteria below, refer for echocardiogram.
  - b. If both are negative, echo is not required.
  - c. We are currently evaluating other criteria that may be more specific for our population.

**DISCUSSION:** In young individuals, the precordial voltages tend to be higher than in older individuals. If voltage criteria alone are used to diagnose LVH, many false positives will result. Below are some criteria for LVH from different authorities. As voltage criteria are not very sensitive or specific, additional EKG criteria can be used to bolster the specificity. Left atrial enlargement, ST segment abnormalities, widening of the QRS, and abnormal R wave progression are supplemental characteristics of LVH. Even with this help, if any questions remain, echocardiography must be obtained.

#### **USAFSAM criteria:**

S in V1 or V2 plus R in V5 or V6:

- 55mm if under 35
- 45mm if over 35
- No ST/T changes

#### **Scott criteria:**

(1) S in V1 or V2 plus R in V5 or V6:

- >35mm >30 y/o
- >45mm >20-30 y/o
- >55mm <20 y/o

(2)

- R in V5 or V6 > 26mm;
- R + S in any V lead > 45mm;
- R in aVL > 7.5mm;
- R in aVF > 20mm;

- or S in aVR > 14mm

**ICD-9 CODES:**

**429.38 LVH**

**402.90 LVH if secondary to hypertension**

### 3.18 PERICARDITIS

**AEROMEDICAL CONCERNS:** Pericardial effusion can lead to acute cardiovascular compromise secondary to cardiac tamponade. Less severe cases can produce pain and shortness of breath that can be distracting in flight.

**WAIVER:** The flier should be grounded during the acute illness. Idiopathic pericarditis can be considered for waiver after the acute episode resolves provided there has been no recurrence or sequelae. The disposition of cases secondary to underlying disease will depend on the disease concerned. Any pericardial effusions must be resolved by echocardiography before waiver recommendations will be made.

**INFORMATION REQUIRED:**

1. Cardiac consultation is necessary to exclude connective tissue disorder, myocardial infarction, neoplasm or other disease processes. The workup should include:
  - a. Echocardiography to rule out sequelae such as pericardial effusion or constrictive pericarditis.

**TREATMENT:** Idiopathic pericarditis is usually self limiting. Rest and aspirin or nonsteroidal anti-inflammatory agents are all that are required for treatment. If maintenance medication is required, then a waiver will not be considered. Waiver recommendations for secondary pericarditis will be based on the underlying disease process.

**DISCUSSION:** 50% of the cases of acute idiopathic pericarditis are viral in origin, usually Coxsackie B. A small minority of cases may progress to pericardial constriction or tamponade. On initial presentation, more than 90% of the patients will have symmetrical ST elevation of most or all ECG leads, which become inverted over the next 2-3 weeks before reverting to normal. Some patients will be left with minor, nonspecific ECG abnormalities.

**ICD-9 CODES:**

**420.9 Acute Idiopathic Pericarditis**

### 3.19 PRE-EXCITATION SYNDROMES

**AEROMEDICAL CONCERNS:** There is a risk of tachyarrhythmias, with symptoms of hemodynamic compromise. There is also an association of pre-excitation with certain types of heart disease.

#### **WAIVER:**

**Designated Personnel:** Should be referred for electrophysiologic studies (EPS). If indicated, radio frequency (RF) ablation can be offered. If RF ablation is performed, a repeat EPS at 4-6 weeks after therapy is required to document control of the arrhythmia. Waiver to SG3 or Class II flying duty can be recommended if the arrhythmia is non-inducible on repeat EPS. After six months, waivers to SG1 or SG2 may be considered. Individuals with symptomatic AV Nodal Re-entrant Tachycardia treated by AV nodal modification will be evaluated on a case by case basis at NOMI. Pilots will be restricted to SG3.

**Applicants:** (1) Candidates with accessory conduction pathways (Wolff-Parkinson-White, ventricular pre-excitation pattern) are NPQ without waiver. (2) Candidates with WPW Syndrome who have had definitive treatment via RF ablation with demonstrable non-conduction on follow-up EPS are considered for waiver on a case by case basis. (3) Candidates who are asymptomatic with incidentally noted accessory bypass tracts which are incapable of sustained rapid conduction as demonstrated by EPS are PQ. Such a procedure is not recommended in asymptomatic individuals.

#### **INFORMATION REQUIRED:**

1. Cardiology evaluation is necessary to exclude such causes as hypertrophic cardiomyopathy or Ebstein's malformation.
2. Waiver recommendations for preexcitation patterns may be made for designated aviators after a non invasive cardiology evaluation, to include:
  - a. Holter monitor
  - b. Echocardiogram
  - c. Exercise treadmill test

**TREATMENT:** Radio frequency catheter ablation has been accepted as a definitive treatment with low risk or recurrence and few complications. There is no indication for ablation of an asymptomatic accessory conduction pathway.

**DISCUSSION:** The condition occurs in 1-3 per 1000 of the population. The lowest incidence of arrhythmia is in young adults without a past history; it is estimated that up to 20% of such individuals will develop tachycardia at some time. It is not possible to predict which patients will develop SVT and which will develop atrial fibrillation with or without catastrophic rapid ventricular response. Studies reporting atrial fibrillation rates up to 40% have been reported.

#### **ICD-9 CODES:**

##### **426.7 Pre-Excitation Syndromes**

**426.81 Lown Ganong Lavine**

**G 702 Wolff-Parkinson-White**

**P3734 Catheter Ablation of Heart Lesion (Specify as Ablation of Accessory Bypass Tract)**

### **3.20 SINUS BRADYCARDIA**

**AEROMEDICAL CONCERNS:** Extreme sinus bradycardia may be a reflection of an underlying conduction system abnormality. There may be an inability to increase the heart rate in response to increased demand.

**WAIVER:** If the heart rate increases with exercise, the bradycardia is NCD, and no waiver is required.

**REQUIRED INFORMATION:**

1. Supply an EKG that demonstrates a HR >45 bpm.

**TREATMENT:** No treatment is indicated if the rate increases with exercise; the condition is NCD.

**DISCUSSION:** A resting HR <45bpm in our population is almost invariably caused by excellent physical conditioning, with high resting vagal tone.

**ICD-9 CODES:**

**427.80 Sinus Bradycardia**

**427.81 Sinus Bradycardia requiring follow-up**



### **3.21 SINUS TACHYCARDIA**

**AEROMEDICAL CONCERNS:** Sinus tachycardia may be a reflection of a significant metabolic abnormality. In candidates, consider anxiety as the root problem. Other causes include fever, hyperthyroidism, dehydration, anemia, hypoxia, pulmonary emboli, and pain.

**WAIVER:** The waiver recommendation will stem from the reason for the tachycardia. If the heart rate is persistently >100 bpm and no cause has been identified, both candidates and designated personnel are CD, no waiver.

**INFORMATION REQUIRED:**

1. Documentation of a search for secondary causes

**DISCUSSION:** Persistent sinus tachycardia is unusual, and its etiology must be determined. Holter monitoring to determine average heart rate and sleeping rate is extremely helpful.

**ICD-9 CODES:**

**785.0 Sinus Tachycardia**

### 3.22 SUPRAVENTRICULAR TACHYCARDIA

**Note:** NOMI's definition of supraventricular tachycardia is 3 or more consecutive nonventricular ectopic beats at a heart rate of greater than 99 BPM. Excluded are atrial fibrillation/flutter and multifocal atrial tachycardia. Recurrent is defined as occurring more than once in any test or during any evaluation. Sustained tachycardia is defined as lasting more than 10 minutes.

**AEROMEDICAL CONCERNS:** The major concern in supraventricular tachycardia (SVT) is hemodynamic decompensation in flight leading to lightheadedness, dizziness, presyncope and loss of consciousness.

**WAIVER:** Only asymptomatic (with the exclusion of the sensation of palpitations as a symptom) cases will be considered for waiver as symptoms are an indication of hemodynamic compromise. **Service Group I waiver recommendations** can be considered for those with the following: episodes of single or recurrent, non-sustained SVT including those with coexisting mitral valve prolapse (MVP), left or right bundle branch block (LBBB or RBBB), mitral regurgitation (MR) and sarcoidosis; a single episode of sustained SVT including those with coexisting MVP, L/RBBB, MR or sarcoidosis. No evidence of CAD can be present if a waiver is requested. Disqualification is mandatory in cases of SVT with hemodynamic compromise, single sustained SVT with gradeable CAD, recurrent, sustained SVT when the recurrence is at intervals <3 years and any SVT associated with a pre-excitation pattern on ECG. Waivers are not recommended for students or candidates. No waivers are recommended for Multifocal Atrial Tachycardia (MAT). Note: In the absence of P-waves, distinguishing between SVT with BBB vs. VT is difficult.

#### **INFORMATION REQUIRED:**

1. Complete cardiology consultation looking for secondary causes is required to include:
  - a. Echocardiogram
  - b. Stress test
  - c. Three Holters during a 6 month grounding period
2. Patients with MAT should be grounded and referred to NOMI for evaluation.
3. For cases of a single, asymptomatic, 3-10 beat run of SVT, only local evaluation is required. This should include:
  - a. Thyroid function testing
  - b. Echocardiogram
  - c. Standard treadmill test
  - d. Three, 24-hour Holters at monthly intervals to identify cardiovascular risk factors
  - e. These studies will be forwarded to NOMI with the waiver request for review. If there is any abnormality, further cardiology evaluation will be required.
4. Note: If LBBB or RBBB is present, a standard treadmill EST is almost impossible to interpret. Preferred studies are stress echocardiogram, thallium stress test or Sestamibi.

**TREATMENT:** N/A.

**DISCUSSION:** Supraventricular tachycardia is characterized by a narrow complex rhythm (except with aberrant conduction in which the QRS will be wide), and P waves are usually hidden. Seventy percent are related to an AV reentry mechanism, 20% involve an accessory conduction pathway (WPW), and 10% are SA nodal in origin. Non reentry SVTs are due to ectopic pacemakers, paroxysmal atrial tachycardia (PAT) with block (think digoxin toxicity although unlikely), or MAT as in COPD patients. In MAT, P waves precede each QRS but have at least 3 different P wave morphologies. An irregularly irregular rhythm and a narrow QRS complex are seen. MAT is often clinically significant and heart disease has to be excluded. The Air Force has reviewed 430 individuals with SVT. Of these, 42 (10%) had symptoms of hemodynamic compromise with syncope, presyncope, lightheadedness, chest discomfort, dyspnea or visual changes. There were also 21 (5%) with recurrent, sustained, asymptomatic SVT. Of those with hemodynamic compromise, 90% had their symptoms on their initial presentation with the remainder developing their symptoms after they were diagnosed as having SVT. Three of these individuals were initially found to have recurrent, sustained SVT and the fourth had a single, sustained SVT. The only cofactor that was associated with either hemodynamic compromise or recurrent, sustained SVT was pre-excitation syndrome (WPW or Lown-Ganong-Levine syndrome).

**ICD-9 CODES:**

**427.0 Supraventricular Tachycardia**

### 3.23 VENOUS THROMBOSIS/PULMONARY EMBOLISM

**AEROMEDICAL CONCERNS:** Pain and swelling secondary to deep venous thrombosis (DVT) can be distracting in flight. The major risk is a pulmonary embolism producing chest pain, shortness of breath, hypoxia, cardiac arrhythmias or sudden death. Dyspnea occurs in nearly 90% of patients with symptomatic pulmonary emboli with syncope occurring occasionally.

**WAIVER:** Waivers will be considered for acute, non-recurrent DVT's after cessation of anticoagulant therapy and in the absence of predisposing factors, such as malignancy or coagulopathies. The development of pulmonary hypertension, the need for continued anticoagulation, or surgical procedures such as plication of the vena cava or insertion of filter devices is CD, no waiver. Superficial thrombophlebitis is NCD.

**INFORMATION REQUIRED:**

1. Confirmation of normal exercise tolerance and pulmonary function is necessary.
2. In cases of pulmonary embolism, internal medicine consultation may be necessary to exclude underlying malignancy or other hypercoagulable states.

**TREATMENT:** The aviator should be grounded for the full duration of anticoagulant therapy.

**DISCUSSION:** 2-5% of the population will suffer from venous thrombosis at some time. Risk factors related to hypercoagulability (e.g. the risk of developing DVT after open prostatectomy has been quoted as 35%) and stasis (e.g. being strapped into an aircraft seat for long sorties) should be considered. In 50% of cases of DVT of the leg there are no signs or symptoms relating to the lower limbs. Untreated, acute iliofemoral venous thrombosis has a 50% chance of causing pulmonary embolus. Up to 30% of such patients have malignant disease. It is estimated that only 20-30% of pulmonary emboli cause symptoms. The vast majority of patients who survive pulmonary embolism will recover to normal or nearly normal cardiac and pulmonary function within 2-8 weeks.

**ICD-9 CODES:**

**453.8 DVT**

**415.1 Pulmonary Embolus**

**451.9 Phlebitis and Thrombophlebitis, site unspecified**

### 3.24 VENTRICULAR TACHYCARDIA

**Note:** NOMI's definition of ventricular tachycardia is 3 or more consecutive, ventricular, ectopic beats at a heart rate greater than 99 bpm. Recurrence is defined as occurring more than once in any Holter monitor or period of workup, or more than once in any subsequent evaluation.

**AEROMEDICAL CONCERNS:** Hemodynamic changes can result in a fall in blood pressure and a reduction in cerebral blood flow. The condition is often associated with underlying heart disease. There is also a risk of sudden death associated with the condition, usually from ventricular fibrillation.

**WAIVER:** Non-Designated and Designated Personnel: CD all DIF, no waiver for either sustained or non-sustained VT.

**INFORMATION REQUIRED:**

1. Complete cardiology evaluation is required to include:
  - a. Echo treadmill test with thallium or Sestamibi
  - b. Echocardiogram
  - c. Three monthly Holter monitors
  - d. Cardiac catheterization must be performed if there is any evidence of ischemia.
  - e. Electrophysiologic studies may be required if there is uncertainty regarding the origin of the tachycardia (VT vs. SVT with aberrant conduction).
    - i. A high quality signal-averaged EKG should be performed prior to EPS.

**TREATMENT:** Anti-arrhythmic drugs impair cardiac function and are incompatible with flying duties. Pacing is also incompatible with flying status.

**DISCUSSION:** In one study, 35% of patients with ventricular tachycardia had a recent myocardial infarct. The symptoms of ventricular tachycardia are incompatible with duty involving flying.

**ICD-9 CODES:**

**427.1 Ventricular Tachycardia**

### 3.25 RAYNAUD'S PHENOMENON:

**AEROMEDICAL CONCERNS:** Raynaud's Phenomenon is an episodic, reversible spasm of the vasculature in the extremities. Typically the hands are primarily effected. During an episode skin changes that occur include:

1. Pallor-caused by lack of oxygenated blood
2. Cyanosis-caused by pooling of poorly oxygenated blood
3. Rubor-occurs as the vasospasm ends

During a severe episode the vascular changes and associated pain can effect hand usage in the cockpit (see discussion).

**WAIVER:** Civilian applicants with Raynaud's Phenomenon are CD, no waiver, per Manual of the Medical Department (MANMED), Article 15-57. Designated aviators with primary Raynaud's Phenomenon will be considered for waiver. Underlying pathology must be excluded and symptoms must be manageable in the performance of flight duties. Designated aviators diagnosed with secondary Raynaud's Phenomenon are CD, no waiver, but may be considered on an individual basis.

#### **INFORMATION REQUIRED:**

1. The following information is used to help rule out secondary underlying causes and must be included:
  - a. Full history
  - b. CBC with differential
  - c. ESR
  - d. Antinuclear antibodies (ANA)
  - e. Hand radiography
  - f. Though not required, nailfold capillary morphology studies may be included.
2. An internal medicine/rheumatology consult must be included to differentiate between primary and secondary Raynaud's Phenomenon.
3. A flight surgeon's analysis of the aviator's ability to perform normal and emergency duties must be included with the waiver submission request.
4. Class I aviators must have their waiver package reviewed by NOMI internal medicine prior to being allowed to return to the cockpit.
5. As more advanced tests become available, please include them with the waiver request.

**TREATMENT:** Drug therapy is discouraged because of the side effects of the drugs in common use. If drug therapy is prescribed to an aviator waived for primary Raynaud's phenomenon, the waiver request must be resubmitted. Behavioral adaptations such as stopping tobacco usage, cold avoidance, and layered clothing are acceptable. Thoracic sympathectomy is not waivable.

**DISCUSSION:** Vasospasm of the extremities can occur as an isolated symptom without underlying disease (primary Raynaud's Phenomenon) or in association with another disorder or condition (secondary Raynaud's Phenomenon). Ninety-eight percent of secondary Raynaud's Phenomenon disorders are connective tissue diseases with systemic sclerosis being the most

common. Raynaud's Phenomenon affects four times more women than men. In women, onset typically occurs between 15 and 40 years; in men the onset is typically later. Despite over a century of investigation, the pathophysiology of Raynaud's Phenomenon remains an enigma. Recent meta-analysis has shown that of the individuals with primary Raynaud's Phenomenon, 13% will develop a secondary disorder within 10 years. Primary Raynaud's Phenomenon will often present with a variety of clinical and serological abnormalities; however, over a lifetime less than one-third will develop a connective tissue disorder.

**ICD-9 CODE:**

**V12.5 K Raynaud's Phenomenon**